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Agricultural Research

Catfish Farming U.S.A.

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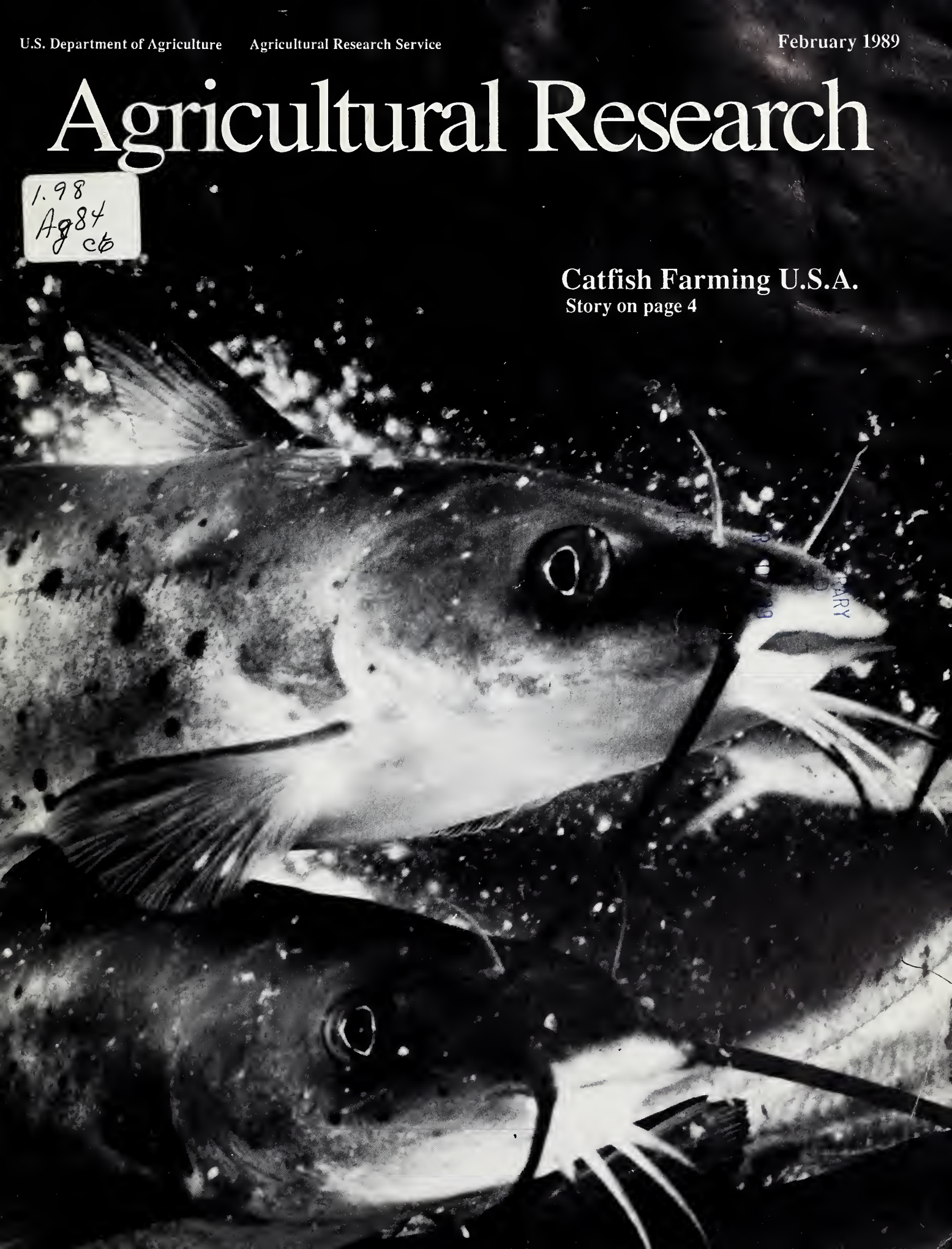


Can We Scale Up Fish Farming?

When you order a shrimp cocktail at a restaurant, chances are 3 to 1 that the shrimp you'll eat are imported from Ecuador, Mexico, or Taiwan.

Our growing appetite for seafood has made fish and fishery products America's third largest import, behind automobiles and electronics.

Traditionally, we haven't been a fish-eating nation. But that's changing. Back in 1960, the average American ate about 10 pounds of fish each year. In 1987, we were up to about 15.4 pounds.

And many people believe that this isn't a flash-in-the-pan fad, but is instead a strong trend. And as long as America remains a net importer, we will continue to miss the boat in this market. In 1987, we exported about $1.5 billion worth of fish and fish products, but we imported $8.8 billion—up 16 percent over 1986.

Our fishing fleets may be as efficient and as competitive as those of other nations in harvesting rivers, bays, and oceans. But we lag behind many fish-producing countries in the art and science of producing fish from the land—in tanks, ponds, or paddies.

With aquaculture, unlike many other forms of American farming, there is no surplus: We are unable to raise a crop big enough to meet our needs. With the notable exceptions of catfish, crawfish, and trout-raising industries, we have yet to capitalize on the tremendous potential for producing an impressive variety of farm-raised fish.

Why isn't fish-farming a larger industry in America? A major reason is that science and technology have yet to provide solutions to some of the problems that typically occur with this method of food production.

Two of these problems are how to feed fish cheaply, and how to keep them healthy.

In the southern United States, catfish farmers pay about $300 a ton for feeds. The availability of nutritious, affordable feed is a major factor fostering the $1 billion-plus catfish producing and processing industry.

Contrast that price with the $750 a ton, and up, that shrimp farmers in Hawaii may pay for top-quality feed, imported from Asia. No wonder that one of the top priorities for ARS aquaculture research in Hawaii is to develop a feed for shrimp that is affordable but still as nutritious as the highest quality imported brands.

Don't expect a quick solution. In the wild, shrimp eat a wide variety of aquatic plants and animals. That means it's difficult for scientists to determine which nutrients in these foods are essential for the best growth. Even worse, shrimp are cannibals; so the best food for a shrimp might actually be its neighbor.

There are dozens of species of shrimp and fish that we'd like to domesticate. However, for many of these species, we know very little about their diseases, and how to diagnose, treat, and prevent them. Disease research is a key part of ARS aquaculture studies in Hawaii; resistance to disease is a critical factor in selection of catfish strains in ARS labs in Mississippi; and new approaches to solving water quality problems are a main part of our experiments in Oklahoma.

In the open ocean, fish may die unnoticed; their deaths don't necessarily represent a loss to the fishing industry. Try raising that same fish in a tank or pond. Every death is obvious—and costly.

Given the problems of expensive feeds, puzzling diseases, and other formidable obstacles facing prospective fish farmers, can we be optimistic about the future of aquaculture in the United States?

Yes. Here's why. In many parts of the country we still have sufficient clean or reusable water, which fisheries require. We have surpluses of grain crops that we may be able to convert into feeds that fish could thrive on. We're developing tools of biotechnology that might make it possible for us to someday produce hardy fish that can thrive in harsh climates.

Perhaps most important, we have farmers and scientists who have shown that they know how to work together to solve farm problems. Fish are, after all, simply another animal we can grow for food.

Look back over the progress we've made in finding creative solutions to the major problems of raising farm animals such as beef cattle and poultry. There's no reason we can't be just as successful with aquatic life.

If we can greatly expand our aquaculture industry, future harvests from those farms—combined with catches from our fishing fleets—might make it possible for us to become self-sufficient, capable of meeting our burgeoning demand for freshwater and marine fish.

Donald W. Freeman
Agricultural Research Service
Mississippi State, Mississippi

Letters

We invite letters from readers and, from time to time, will share them in this column.—Ed.

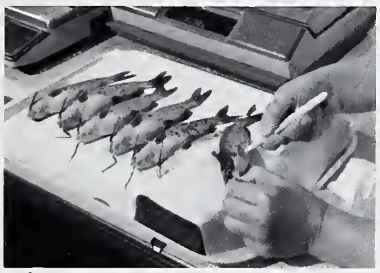
The article on *Hot Peppers Spice up Profits for Farmers* in the November/December 1988 issue misidentified the people in its accompanying photograph. Richard Fery, Charleston, S.C.

The correct caption:

ARS geneticist Richard Fery (R) and plant pathologist Philip Dukes (C) check Carolina Cayenne peppers with grower Alec Gillespie. (88BW1819-34)

Agricultural Research

Cover: Male catfish at the Agricultural Research Service's Catfish Genetics Research Laboratory in Stoneville, Mississippi. (88BW2282-34) Photo by Barry Fitzgerald.



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Agricultural Research Service

Catfish Farming
It's A Male-Order Business

Having observed that male catfish grow faster than female catfish, U.S. Department of Agriculture geneticist Gary J. Carmichael and reproductive physiologist Cheryl A. Goudie are studying ways science might ensure that male catfish outnumber females.

Carmichael is research leader at the Catfish Genetics Research Laboratory operated by USDA's Agricultural Research Service at Stoneville, Mississippi.

He and Goudie have joined an 8-year effort begun by scientists at Memphis State University and the U.S. Fish and Wildlife Service's Southeastern Fish Cultural Laboratory at Marion, Alabama. Researchers there broke new ground in trying to evaluate sex determination methods and to find ways to select gender in channel catfish.

Considered among the nation's fastest growing agricultural enterprises, catfish aquaculture totaled slightly more than 372 million pounds in 1987, with a farm value of nearly $277 million, for a growth rate of about 14 percent over the previous year. Per capita consumption in 1987 was up 23 percent over the previous year to three-fourths of a pound.

The mission of the Stoneville laboratory is to evaluate various strains of catfish, comparing such factors as growth rate, feed conversion, disease resistance, body composition, ability to tolerate chemicals and changes in water quality, and the seine-ability of the fish—whether the fish will be skittish at harvest time and try to swim around the net or burrow into the mud below it. However, the intriguing matter of control of catfish sex developed into a secondary objective.

"Mississippi State University has a 3-year study underway in which scientists are looking at two ways of harvesting," Carmichael says. "One of these is "topping"—using a seine with a selective mesh size that will take only the largest fish. We're working to evaluate the proportion of males in the harvest.

"We took 200 fish from those harvested from each of 16 ponds, and we've checked the sex on them. After a second sampling, including pond draining, we'll have percentages of males to females.

"Then we'll apply techniques that we have to try to make an all-male population for harvesting."

BARRY FITZGERALD

Evaluating various strains of catfish, reproductive physiologist Cheryl Goudie and geneticist Gary Carmichael check for such factors as growth rate, disease resistance, and feed conversion. They also measure the catfish's ability to tolerate chemicals and changes in water quality. (88BW2286-7)

Hormones: A Gender Bender

The idea of switching the sex of fish is not as farfetched as it might sound. Carmichael says research has already shown that young fish of many species will turn into males when treated with male hormones, while treatments with female hormones will make the fish female. But catfish are a puzzling exception to that rule.

Goudie recalls that earlier tests by the Fish and Wildlife Service in conjunction with Memphis State University turned up some odd results on catfish.

"We looked at 17 male hormones in different combinations," she says. "These were all strong masculinizing agents. But when we put them in the diet of swim-up fry—catfish about 7 to 10 days after hatching—it made them all female. One project by a graduate student suggested one hormone leaned toward producing males, but we haven't substantiated that result yet. We can change a catfish's sex but not in the direction we want."

However, in May, Memphis State began working with the ARS laboratory at Stoneville on tests with dihydrotestosterone or DHT, believed to be one of the strongest masculinizing agents.

Daily doses of DHT were added to fish eggs' water each day at three levels ranging from 0.2 to 200 micrograms per liter of water until the eggs developed into sac-fry.

Some of the fish were then taken off the treatment to grow normally thereafter. Others continued the treatments for 7 more days, until they developed into swim-up fry. The group was again divided, with some of the fry taken off treatment and others continuing to receive the DHT dosages in their feed.

If DHT does turn catfish into males, Carmichael anticipates little trouble in getting approval from the federal Food and Drug Administration for consumption of the sex-switched fish.

"DHT is a naturally occurring hormone in humans," he says. "And we think the fish will metabolize the hormone naturally by the time we eat them anyway."

One result of the earlier work with male hormones on catfish was the production of phenotypic females, fish that are externally female but have the XY chromosome makeup of males, rather than the usual XX chromosome makeup of females.

Goudie says that if a normal XY male fish is mated with an XY female, the result in some instances could be an offspring with a YY chromosome package.

"The YY genotype in mammals is usually lethal," she notes. "There are too many missing genes that are essential for survival.

"But the YY combination in catfish is apparently viable. And if you mated a YY male with an XX female, you'd get all XY fish—an all-male population."

However, researchers cannot tell from looking at a catfish's DNA whether that fish is male or female, making it difficult to pinpoint the vital YY males.

"Typically, you could take the DNA content from a cell, of say a human male, and just measure it," says Goudie. "A Y is really a reduced X, so since a male is XY, the male usually has 1 to 4 percent less DNA than a female. If you had a YY, you'd expect to see even less DNA—but that didn't work in catfish. So we're going to have to analyze the ingredients of the DNA and see if we can find some differences.

"Male catfish are 10 to 15 percent heavier than females when you send them to market. This difference may not seem very big, but translated over millions of pounds of fish every year, a faster growth rate for males could mean a lot of money to the catfish producers. We think this work will have a direct effect on the industry."

BARRY FITZGERALD

Animal caretaker Rob Tate (foreground) and geneticist Gary Carmichael feed floating pellets to a strain of blue catfish used in genetic research. The Catfish Genetics Research Laboratory's "wet lab" houses more than 400 fish tanks ranging in size from 20 to 200 gallons. (88BW2274-10)

Different Strains of Catfish on the Menu

The laboratory's primary mission is catfish strain evaluation. The scientists are currently focusing on the Red River strain, the northernmost catfish, seen in North Dakota and Canada; the Kansas strain, which has been in hatcheries or research facilities since 1911; Mississippi, the fish typically used in the delta and originating in the Mississippi River; Marion, originally from Marion, Alabama; and Blue.

Catfish *(Continued)*

BOB BJORK

At the Tishimingo National Fish Hatchery, ARS biologist Wendell Lorio (left) and U.S. Fish and Wildlife technician Larry Norton (right) examine a catfish with Gary Ainsworth of the RedArk Development Authority. Created in 1984 by the Oklahoma state government, RedArk helps farmers grow and market catfish and other crops. (0887X831-10)

BARRY FITZGERALD

Gary Carmichael and Cheryl Goudie checking the sex of catfish treated with a hormone—dihydrotestosterone. DHT, if given in an early stage of development, may cause catfish to become all males. (88BW2272-8)

Although the Red River, Kansas, Mississippi, and Marion are all strains of channel catfish, the Blue is a different species. According to Carmichael, offspring produced by the mating of a Blue male and a channel female grow especially well: "The Blue/channel hybrid developed at Auburn University may grow up to 15 percent faster than others."

"It would be nice to think we could develop a better fish for the catfish industry," says Goudie. "But we may only be able to characterize variability—to write a menu of how the different fish do on water quality tolerance or disease resistance. Then farmers might be able to simply choose the fish to suit their needs."

Can Water Be Recirculated?

At the Tishimingo, Oklahoma, National Fish Hatchery, ARS research biologist Wendell Lorio is concentrating on making a comfortable and healthy home for catfish as they gobble their way to market size.

"We're looking at water recirculation as one technique to improve channel catfish production," says Lorio. "Down the road, I think water quantity is going to be a limiting problem.

"In Oklahoma, there's a lot of surface water but very little well water. In Mississippi, the water table has dropped 15 feet since 1968; the underground water supply in the Mississippi delta is being already affected by catfish production."

Now in the third year of a 5-year study, Lorio has been recirculating the water in catfish ponds through biological filters loaded with bacteria. Hopefully, the bacteria will remove ammonia and nitrite from the water. These are products of wasted feed and fish excrement.

"High ammonia in the water may kill fish," Lorio explains. "Even if it doesn't kill them, it reduces their growth rate because they don't eat as

well. The added stress may lead to serious disease problems."

The study compares the results of continuous pumping versus pumping for 12 hours at night. Lorio says the system pumps about 60 gallons a minute with a 1.5-horsepower 2-inch pump. Twelve one-tenth-acre ponds and two 1-acre ponds are being used.

"When you try to intensify production, you have problems with ammonia," he notes. "We're looking at 7,500 fish per acre in our ponds, but in Mississippi they stock that much and even higher. In Oklahoma, farmers are stocking 3,500 to 4,000 per acre, but they are dependent on just run-off water.

A Matter of Good Taste

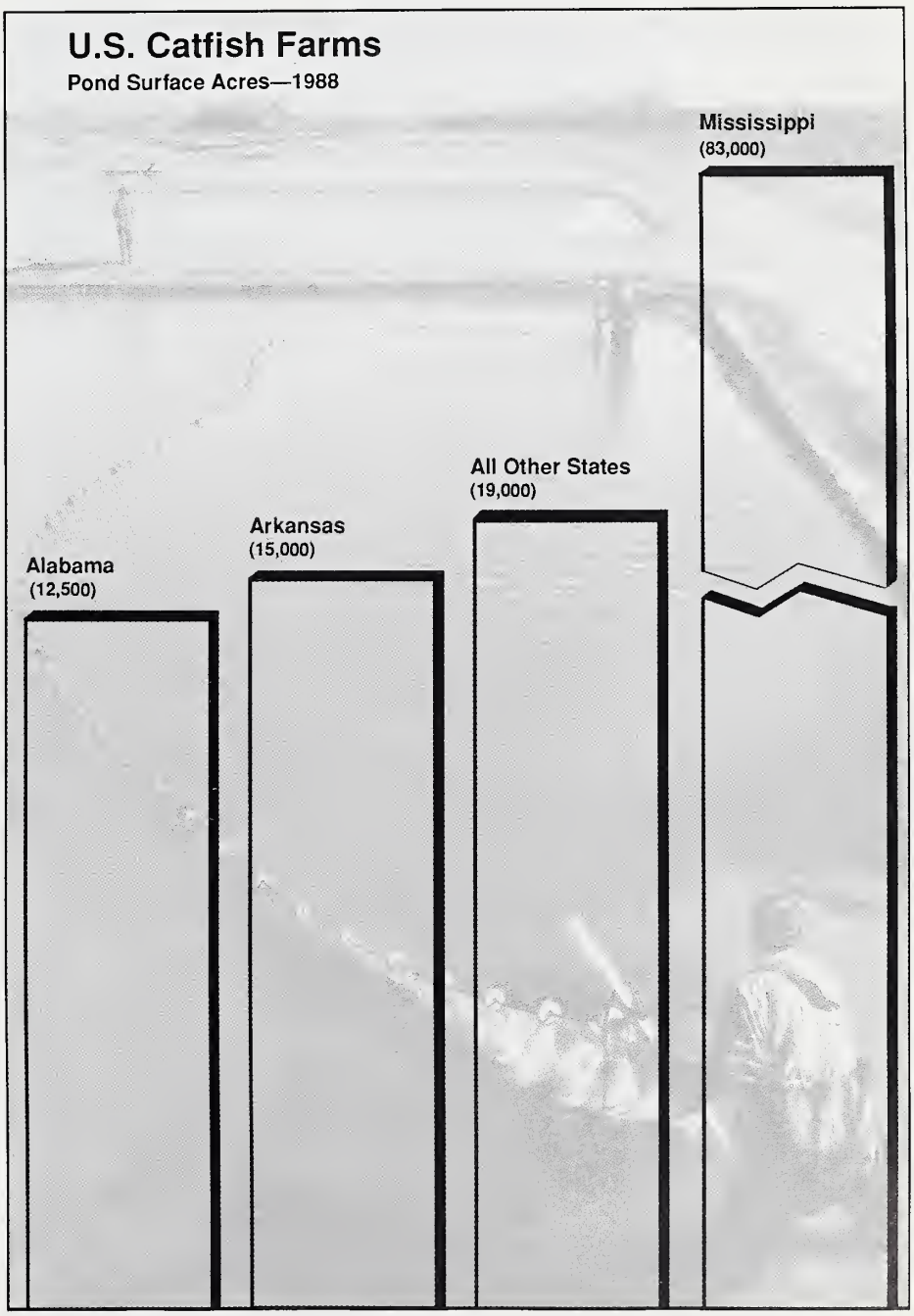
"We're looking for some economically feasible way to increase production and still maintain a quality fish. High ammonia increases production of plankton, which releases off-flavor compounds into the water that are picked up by the fish. If you raise them and you can't sell them, you don't have anything."

Those off-flavor compounds are the special concern of Peter B. Johnsen, a research physiologist at the Food Flavor Quality Research unit of ARS' Southern Regional Research Center at New Orleans, Louisiana.

"The way fish are produced now—in very high concentrations in earthen ponds—results in tremendous blooms of blue-green algae," Johnsen explains. "These impart an earthy, musty flavor to the water, and that's picked up by the fish.

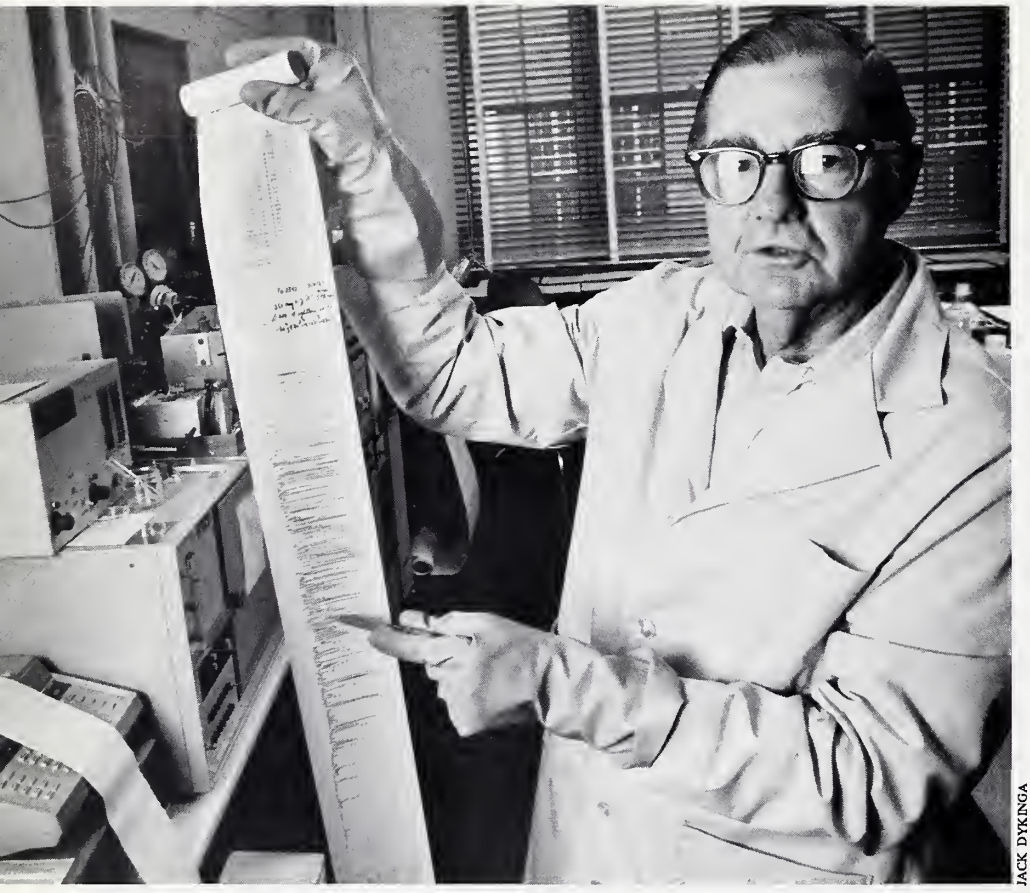
"These compounds are the same ones that give dirt its smell. Humans can taste them at only one part in 100 billion; they are among the most potent flavor compounds known."

"At any one time, an estimated 50 percent of the harvestable fish are off-



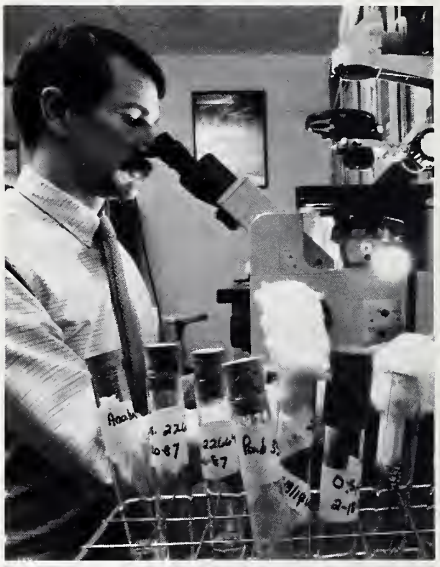
Total pond area in catfish production in 1988 was 130,252 acres (preliminary), nearly double the 1982 acreage of 73,840. Source: USDA—Economic Research Service. (88BW2277-13)

Catfish *(Continued)*



JACK DYKINGA

Chemist Harold Dupuy, now retired, with an aromagram of catfish odors derived from the flesh of farm-raised catfish. Objective of the still ongoing project is to relate the chemical composition of catfish with human taste and smell experience. (0387X138-15A)



JACK DYKINGA

Physiologist Peter B. Johnsen isolates and identifies blue-green algae from farm catfish ponds. Algae can impart a muddy off-flavor to the water that is picked up by the fish. (0387X128-34)

flavor, and from midsummer to late winter, it goes to 80 percent.

"We've shown that if fish are in water with about 0.5 part per billion of the metabolites, in 2 hours' time they'll be off-flavor. While fish pick up the bad taste in a few hours, it takes several weeks for the compounds to be flushed from their bodies, so that they taste good again.

"The economic impact of this is very large," he says. "If the fish are off-flavor, the producer can't take them to market when he needs to, and there's a cash-flow bind. Also, the fish keep growing and get too large for the preferred market size—about 1-1/2 pounds.

"Besides, feed conversion drops as the fish get bigger. The fish begin laying down more fat instead of muscle.

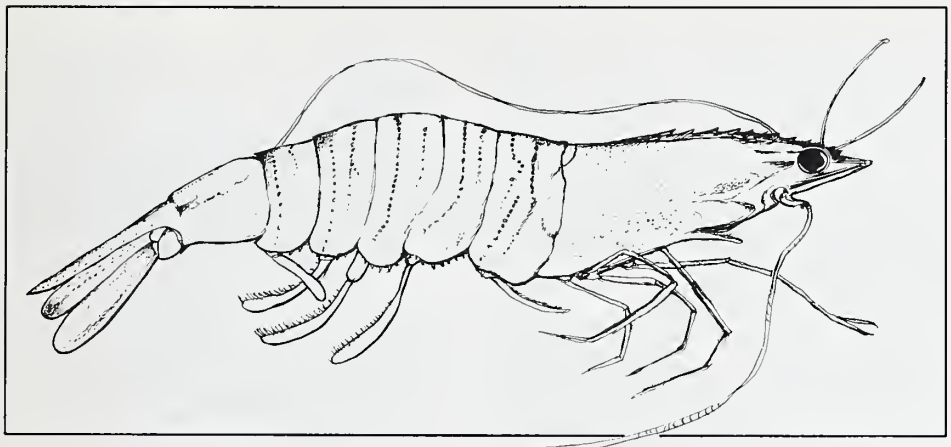
"Also, the producer is exposing himself to total financial ruin through disease loss, because the longer the fish are out there, the more risk he runs."

There are still many unanswered questions about the off-flavor compounds, Johnsen notes.

"The compounds cycle in the pond and are degraded in ways we don't understand," he says. "Not all organisms of the same species produce the compounds, and among the ones that do, sometimes they express the compounds and sometimes they don't. Something is triggering it; we have microbiologists looking for that trigger. Once we identify it, we hope to find the chemical process by which the algae make the compounds, and perhaps block that process."—By **Sandy Miller Hays**, ARS.

Gary J. Carmichael and Cheryl A. Goudie are in USDA-ARS Catfish Genetics Research, P.O. Box 38, Stoneville, MS 38776 (601) 686-2987. Wendell J. Lorio is in the USDA-ARS South Central Agricultural Research Laboratory, P.O. 159, Lane, OK 74555 (405) 384-5390. Peter B. Johnsen is in USDA-ARS Food Flavor Quality Research at the Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70179 (504) 286-4421. ♦

Pond-Raised Shrimp Thrive on Sugarcane



A sugarcane-based food for shrimp might make it easier and cheaper for U.S. fish farmers in Hawaii and other tropical areas to compete for a larger share of the market for this popular seafood.

Results from a 12-week experiment indicate that young, pond-raised marine shrimp grow well on small pellets of the experimental feed, says Donald W. Freeman, with ARS at Mississippi State, Mississippi.

The pellets are made from bagasse—the crushed stalks that remain after sugarcane is processed—and from inexpensive forms of protein, fats, and minerals.

Freeman developed and tested the food when he was at ARS' Tropical Aquaculture Research unit. It's located with the Oceanic Institute, a nonprofit research organization at Makapuu Point, about 15 miles east of Honolulu, Hawaii.

Institute scientists helped with the test, using a succulent, very popular variety of shrimp known as *Penaeus vannamei.*

Shrimp ate not only the decomposing fibers of the bagasse pellets, but also the bacteria, algae, and microscopic zoo-plankton that feed on the pellets and proliferate. The pellets sink to the bottom of the pond, providing new surfaces the tiny pond creatures can attach to and eat.

Feed costs are one of the shrimp farmer's largest expenses. Because bagasse is cheap and plentiful in Hawaii, where sugarcane is grown, the experimental bagasse pellets cost only about $100 a ton. Commercial feeds that give comparable results cost $300 to $450 a ton. And the very best brands of shrimp feed, all made in the Orient, can cost anywhere from $750 a ton and up.

Growth of the bagasse-fed shrimp was comparable to that of shrimp raised in similar ponds but fed low-cost commercial feed.

The most recent annual figures on U.S. shrimp imports show that foreign supplies account for 76 percent of the shrimp consumed in this country. In 1987, Americans bought some 765 million pounds of imported and U.S.-harvested shrimp, worth at least $1.2 billion wholesale.

Small-scale fish farmers in Hawaii, the Virgin Islands, Puerto Rico, and other tropical areas where sugarcane is grown "might be able to raise shrimp economically by feeding the bagasse pellets," Freeman says.

The pellets may be best suited for semi-intensive fish farming, in which a moderate number of shrimp are raised in low-cost, saltwater-filled earthen ponds. (Dried feedlot manure also works well as a source of nutrients for the pond microorganisms that shrimp eat—and costs about the same as the experimental bagasse pellets—but has what Freeman describes as "image problems.")

The bagasse-based pellets aren't intended for high-yielding, intensive fish farming, in which much larger numbers of shrimp are crowded into ponds or into channels known as raceways. In that type of farming, most of the nutritious pond microorganisms aren't allowed to grow, so shrimp must have better quality feeds to make up for nutrients the missing microorganisms might otherwise provide.

Another way to cut down the cost of shrimp feed might be to boost the amount of plant protein, such as that from soybeans, in the feed, says Chhorn E. Lim, leader of the Tropical Aquaculture Research unit at Makapuu Point.

Lim and Oceanic Institute scientists want to develop an inexpensive, soybean-based formula that has a balance of nutrients shrimp need. Soybeans are rich in protein, readily available, and may be a good, partial substitute for squid, fish meal, or some of the other, more expensive ingredients in the best quality shrimp feeds.—By **Marcia Wood,** ARS.

Donald W. Freeman is with USDA-ARS at the A.B. McKay Food Laboratory, Mississippi State, MS 39762 (601) 325-3200. Chhorn E. Lim is at the USDA-ARS Tropical Aquaculture Research Unit, Oceanic Institute, Makapuu Point, Waimanalo, Hawaii 96795 (808) 259-7951. ♦

Meadowfoam: *Pretty Flowers, Pretty Possibil*

From a distance, it looks like a canopy of white foam rising gently from a rich green valley. But to the growers of meadowfoam, a low-growing winter annual, what counts most is not the flower but the valuable oil cached away inside the plant's seeds.

"The flowers look brilliantly white, almost unnaturally so," says Marvin Ringsdorf, a meadowfoam grower in western Oregon. "But as pretty as they are, that's just not where the money lies."

The seeds are pear-shaped, striated, and tiny; they look like miniature spurs. These thin hulls encase a most unique oil, a rich source of long-chain fatty acids, not found in other commercial oils, that can easily be made into soap, hair-care products, and moisturizers. Meadowfoam oil may also have potential in the production of industrial lubricants, polymers, waxes, and lactones. Researchers say it is one of the most stable vegetable oils known.

In the period 1984-86, the Oregon Meadowfoam Growers Association sold 12 tons of the oil to the Japanese cosmetics industry. A smaller amount was sold to Canadian firms, and samples were sent to the European Economic Community. Despite its promise, though, future use of the plant remains uncertain, says Dave Nelson, the association's executive secretary.

"The largest single deterrent to the successful marketing of meadowfoam oil is its cost," he says. "And that's tied to the small yield we've experienced to this point."

While meadowfoam yields about 1,000 pounds of seed per acre, the seeds (called nutlets) produce only 20 to 30 percent oil.

"Like the laser in its early days," Nelson says, "the great promise of meadowfoam inspires lots of speculation, but we have to admit that its best uses have probably not been uncovered."

DAVE KING/OREGON STATE UNIVERSITY

Meadowfoam in Oregon.

Scientists with USDA's Agricultural Research Service have been struggling with that matter on and off for nearly 30 years. At the Northern Regional Research Center in Peoria, Illinois, meadowfoam seed oil was first examined in the late 1950's. Analyzing the oil was part of a program to search for new industrial raw materials from plants.

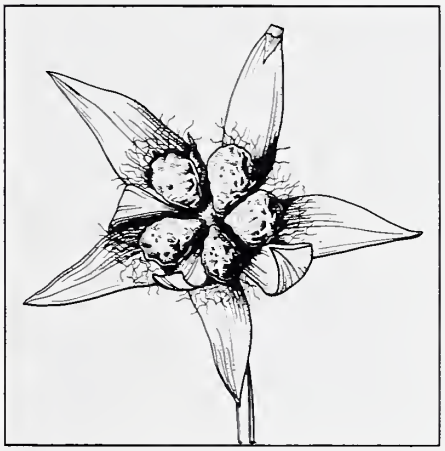
Today, meadowfoam *(Limnanthes alba)* is part of an energetic new crops program headed by chemist Robert Kleiman at the Peoria lab. Along with two full-time researchers, Kleiman explores industrial applications for meadowfoam oil.

"Very simply stated, our objective is to commercialize the oil," he says. "And the way we hope to do that is by making products that are better than those that are currently found in industry.

"We don't expect that all of the potential applications we find will be

DAVE KING/OREGON STATE UNIVERSITY

White flowers contrast with the pear-shaped seed pods (right). The seed oil can be used in industrial lubricants, polymers, waxes, and lactones.



KAREN PARKER

Nutlets contain 20 to 30 percent oil. Scientists would like to increase this yield.

used. But we want people to get interested in what we may be able to do with the oil, be it lubricant or cosmetic base."

Kleiman's samples of oil come from the Oregon Meadowfoam Growers Association, with which ARS has a memorandum of understanding to collaborate in exploiting meadowfoam oil. The agency also operates under a cooperative agreement with Oregon State University, where plant scientist Gary Jolliff and others are attempting to increase the amount of seed oil yield per acre.

Although native to the Pacific Northwest and Vancouver Island, British Columbia, meadowfoam has been grown to a limited extent in parts of the eastern United States, Alaska, and western Europe. "It is definitely not limited to any single area of the country," Kleiman says.

Normally planted in the fall and harvested in early summer, meadowfoam is best suited to mild climates where soil temperatures for germination range from 40°F to 60°F. The plant is 10 to 18 inches tall at maturity.—By **Matt Bosisio,** ARS.

Robert Kleiman is in the USDA-ARS New Crops Research Unit, Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604 (309) 685-4011. ♦

Vitamin E May Boost Immunity in Old Age

This is a tale of mice and men—and a tale of help for the elderly. No, science has not yet discovered a fountain of youth. But one aspect of aging that is often accepted as inevitable—increased vulnerability to disease—may not be so inevitable after all, according to the findings of an animal study that focused on elderly rodents.

Scientists at the Agricultural Research Service Human Nutrition Research Center on Aging at Tufts University are finding that certain dietary antioxidants, particularly vitamin E, can stimulate some of the flagging immune responses in older men and women as well as in aged mice. Antioxidants inhibit chemical reactions such as the breakdown of certain fats.

The immune system appears to parallel the aging process; it gets weaker and slower to react. "Nutritional problems may contribute to declining immunity in old age. And appropriate dietary intervention or supplementation may improve immune function and reduce the burden of illness in the elderly," says nutritionist Simin Nikbin Meydani. She studies such questions in the center's nutritional immunology and toxicology lab, collaborating with nutritionist Mohsen Meydani, her husband, and research leader Jeffrey B. Blumberg.

The immune systems of 2-year-old mice—old age for mice—responded more like those of young mice when the animals were fed vitamin E at 18 times the recommended dietary allowance for 6 weeks. Another antioxidant, glutathione, also stimulated immunity in old mice, says Meydani, but neither compound completely restored it to the level of young animals.

In a pilot study of 32 men and women, about two-thirds of the volunteers who got vitamin E supplements had significant improvement in the immune cell function known to decline with aging. However, there was no improvement in antibody production.

"The results are certainly encouraging," says Meydani, noting that more studies are needed to confirm these findings and to establish how much vitamin E is needed and for how long.

TIM McCABE

Nutritionist Simin M. Meydani administers a delayed hypersensitivity skin test to see if vitamin E supplements can boost the immune system in healthy, older people. (0286X135-35)

Half the volunteers, who were all over 60, took 800 international units (I.U.) of the vitamin daily for a month while the other half got a placebo. At 53 and 67 times the Recommended Dietary Allowance for men and women, respectively, the 800-I.U. dose was not out of line with what some people are taking as supplements.

Many of the vitamin E preparations come in 400-I.U. capsules, she says. "We wanted to maximize dosage to see if there was an effect and work down from there."

Although Vitamin E is substantially less toxic than other fat-soluble vitamins such as A and D, excessive use should be avoided without medical supervision.

In her study, the 16 men and women taking supplements averaged three times more vitamin E in their plasma after the 30-day trial than before. And they started the study with normal levels.

In the last decade, she says, research has shown that "diet and nutrition play an important role in maintaining immune function and protecting against infectious diseases and cancer." For example, restricting animals' calorie intake while providing all the essential vitamins and minerals prolongs their life and preserves their immune function.

Just how diets or nutrients affect the immune system, biochemically speaking, is still very sketchy or unknown. In the mouse and human studies, vitamin E increased levels of interleukin-2, a substance that promotes the growth of certain infection-fighting white blood cells (lymphocytes); at the same time it decreased levels of prostaglandin E_2, which has the opposite effect.

It's well established that the white blood cells function less efficiently with age. Of the four major immune cell types, T cells are the hardest hit. And these were the cells that responded to vitamin E. Meydani and colleagues ran five immune cell tests before and after vitamin E supplementation: Two were specific for T-cell function, two were specific for other immune cell types, and one was a skin test, similar to a tuberculin or allergy

test, that measures the general body response to a familiar antigen. None of the volunteers who got the placebo showed improvement. About two-thirds of those who got the vitamin had significant improvement in the skin test and the two T-cell tests but not in the tests for other immune cells. The evidence is contradictory as to whether other immune cells become less responsive with age anyway, says Meydani.

Although the majority showed improvement, she says, "some showed a very small improvement in individual tests while others showed a large improvement. And the group as a whole differed in their level of response to individual tests." She emphasizes that all the volunteers were healthy. "Vitamin E may or may not restore immune function in people with disease. It hasn't been tested."

Two other antioxidants, vitamin C and glutathione, have also boosted immune response in studies with people or animals such as mice, she says. Glutathione is a small peptide abundant in living cells. Like other antioxidants, it protects the delicate machinery from the ravages of free radicals.

Free radicals are chemical oxidizing agents that result from normal metabolism. Among their targets, free radicals break down unsaturated fats found in all cell membranes by snatching hydrogen atoms out of the fatty acid chain. The oxidized fats themselves become free radicals that generate more of the same if left unchecked. Vitamin E and other antioxidants halt the cascade effect by replacing the stolen hydrogen atoms.

Free radicals—with their potential for damaging cell membranes and DNA—are known to increase with age and may be the underlying factor in the depressed immune response, says Meydani.—By **Judy McBride,** ARS.

Simin Nikbin Meydani is at the USDA-ARS Human Nutrition Research Center on Aging at Tufts University, 711 Washington St., Boston, MA 02111 (617) 556-3129. ♦

Poultry Diseases

Fowl Threats to Broiler Industry

Don Witzel is breathing new life into research on ascites, a cardio-pulmonary disease of chickens that is taking an ever-increasing bite out of poultry producers' profits.

Witzel is a veterinary physiologist for the Agricultural Research Service at College Station, Texas. There, at the Veterinary Toxicology and Entomology Laboratory, he has been housing broilers in simulated high-altitude chambers that leave the birds with as much as a sixfold increase in the occurrence of the disease.

Ascites is a very serious problem for the broiler industry in the higher elevations of Mexico and South America. But it has intensified in the past decade within the U.S. broiler industry as producers have sped up the production process to rush birds to market.

"The birds are growing faster than their cardiopulmonary system can provide the oxygen their bodies need," says Witzel. "The frequency and severity of the ascites problem is increasing, even in low-altitude areas of the United States."

Death rates in the birds average 4 to 5 percent of affected flocks but have been known to hit 50 percent.

"If they don't die, even if they reach a good market weight, they'll be condemned by the meat inspectors at slaughter," he adds.

Low Oxygen May Contribute to Ascites

To test the role oxygen deprivation plays in causing this condition, Witzel and fellow researchers divided 45 week-old Hubbard broiler chicks into three groups. One group of chicks spent 5 weeks last summer in a chamber simulating oxygen availability at an altitude of 9,500 feet above sea level, one group lived in oxygen equal to that available at 8,000 feet, and another group breathed oxygen equivalent to 6,500 feet.

"For every bird with ascites at the 6,500 level, there were two at the 8,000

CHRISTINE KEITH

Don Witzel, an ARS veterinary physiologist at College Station, Texas, uses a simulated-high-altitude growth chamber to test the relationship between decreased oxygen and a poultry disease known as ascites. (88BW2241-4)

level and six at the 9,500 level," Witzel says. "And at 6 weeks old, the birds in the 9,500-foot altitude chamber weighed an average of 1.16 pounds less than the same age birds we'd grown normally as a control group."

Now that Witzel can produce ascites in his high-altitude laboratory chambers, he plans to start searching for other factors that may contribute to the disease, such as viruses or tainted feed.

"We probably still have 2 or 3 years of research to do," he says. "In January, we began looking at different levels of mycotoxins—toxins caused by molds in feed—and other feed additives.

"In the long term, the solution may be to breed poultry lines where the cardiovascular system develops more rapidly or has greater oxygen-carrying capacity than it has now. Perhaps birds could be bred to have a larger heart."

Poultry Diseases a Costly Problem

Witzel isn't the only ARS scientist tackling poultry health problems. At the Protozoan Diseases Laboratory at Beltsville, Maryland, supervisory microbiologist Michael D. Ruff is studying coccidiosis, a disease known since the 1600's and watched closely in birds since the early 1900's.

"It's caused by any one of several different one-celled organisms, all very host-specific," Ruff says. "The ones in chickens don't get in turkeys, for example. So the control has to be very specific,too."

Coccidiosis is estimated to cost U.S. poultry producers more than $200 million a year in slowed growth, lost feed efficiency, and loss of the yellow skin color favored by some consumers and estimated to bring an extra 6 to 10 cents per pound for the chicken. In addition, Ruff says, poultry producers shell out another $90 million a year for medication.

Ruff and his fellow researchers hope to develop a coccidiosis vaccine made from proteins produced by cloning genetic material from the parasites themselves.

"But we have to find proteins that protect against all species of coccidia," Ruff says. "We may have to put together protein from several different types of coccidia."

At ARS' Southeast Poultry Research Laboratory at Athens, Georgia, veterinary virologist Charles W. Beard is leading research efforts aimed at combating lethal Newcastle disease, which can be introduced into the United States by exotic species and is the reason for federal controls on imported birds. His group is also researching avian influenza, which broke out in Pennsylvania and Virginia poultry flocks in 1983, an outbreak that eventually cost the federal government $63 million to control.

Beard's team demonstrated that a single vaccine can protect against as many as 4 of the 13 known avian influenza strains that affect poultry. In the fight against Newcastle disease, they are searching for a genetic basis for the disease-producing capability of the more virulent strains of the virus and to protect birds against the threat.

Meanwhile, at the Regional Poultry Research Laboratory at East Lansing, Michigan, veterinary virologist Richard L. Witter leads a team in efforts to insert genes into chickens' genetic makeup that will give those birds—and their offspring—resistance to specific diseases. The scientists have already introduced one type of foreign gene into the birds' genetic makeup that provides resistance to lymphoid leukosis virus, which causes an important disease of chickens.—By **Sandy Miller Hays**, ARS.

Donald A. Witzel is in USDA-ARS Mycotoxin Research, Veterinary Toxicology and Entomology Laboratory, College Station, TX 77841 (409) 260-9420. Michael D. Ruff is at the USDA-ARS Protozoan Diseases Laboratory, Bldg. 1040, BARC-E, Beltsville, MD 20705 (301) 344-2300. Richard L. Witter is at the USDA-ARS Regional Poultry Research Laboratory, 3606 East Mount Hope Road, East Lansing, MI 48823, (517) 337-6828. Charles W. Beard is at the USDA-ARS Southeast Poultry Research Laboratory, 934 College Station Rd. Athens, GA 30604 (404) 546-3432. ♦

Frozen Soil Pulls

All is not so still beneath the deep snows of America's north country.

Agricultural Research Service winter studies in a Minnesota cornfield are sorting out some frosty secrets for use in upcoming computer models that predict soil erosion by wind or water as well as possible pollution from agricultural chemicals.

The studies, now in their seventh winter, monitor underground freeze/thaw cycles and the resulting soil changes that can help or hinder crop growth and soil erosion. Freeze/thaw cycles affect pollution because they can increase the movement of soil and water, both of which can carry fertilizers and pesticides off fields.

"The results of our studies should apply to all frost-susceptible areas in the world," says George R. Benoit, an ARS soil scientist in Morris, Minnesota. "Areas like Minnesota have frozen ground for 4 or 5 months. That makes frost a major factor."

Benoit and colleagues at the ARS North Central Soil Conservation Research Laboratory in Morris are developing a computer model to simulate frost development and thawing under various farming methods.

"When this model is merged with the erosion and pollution models, we will end up with models that are applicable yearround," says Benoit. "In the past, we've mainly paid attention to spring planting and fall harvest, ignoring the winter. But there's a lot going on under all that snow." The limited work done so far points to a complex interaction of frozen soil with climate and tillage and other factors. This interaction can have a marked influence on the effectiveness of an increasingly popular technique called no-till, a form of conservation tillage.

No-till farmers don't plow; they just plant seeds in a slot cut through the residue of the previous crop. The technique conserves soil water and greatly reduces erosion. It also saves farmers time and fuel.

Studies indicate that how well no-till succeeds in reducing erosion and

Water Up From Below

DON BRENEMAN

Reading underground frost depths in a Morris, Minnesota, cornfield helps soil scientist George Benoit build a better computer model that accounts for freezing and thawing's effects on soil moisture and erodibility. (88BW2246-6)

maintaining or increasing crop yields can depend strongly on soil frost.

"This is particularly true for northern climates," says Benoit, "where freezing and thawing strongly interact with tillage to determine the soil's susceptibility to erosion and to influence the timing of spring planting. This may explain the different results scientists are getting from no-till in northern and southern parts of the country. Conservation tillage methods that seem best for the south are not necessarily best for the north."

The ARS studies in Minnesota compared no-till with moldboard and chisel plowing.

Their findings verified past studies: Cornstalks left standing a foot to a foot and a half above ground trap snow like a snow fence.

Deeper snow on no-till plots insulated the soil, raising its winter temperature by as much as 9°F and keeping frost shallow. During the 1983-84 winter, which was exceptionally cold even by Minnesota standards, the plowed soil averaged 3-1/2 inches of snow compared to no-till's 13 inches. The plowed soil also had frost more than than 2 feet deeper.

The Behavior of Frost

Frost can melt as much as a month sooner on fields with standing cornstalks than on plowed or chiseled soil.

Plastic tubes inserted 5 feet into the ground were used to measure frost depth. Snow depth was measured against markings on the above-ground section of each tube.

The depth of frost is important because frost development causes a redistribution of soil moisture that lasts into spring. Frozen soil is not always a barrier to water movement from above or below. As it freezes, the soil acts as a sponge, drawing water up from unfrozen areas below.

This happens because each particle of frozen soil is actually coated with a film of unfrozen water—even in the coldest weather. Water molecules nearest the soil particles are kept from freezing into crystalline ice by the energy bonding them to the surface of clays and associated cations. This prevents them from fitting the ice crystal structure.

The thickness of this nonfreezing film varies with temperature. In very cold weather, it may be so thin it forms a one-molecule-thick layer. The water films around the particles are usually interconnected. When they are and the temperature is near melting, they allow water to pass slowly through the still-frozen soil.

The direction of water movement below frozen soil depends on how wet or dry a soil is when it freezes. Extremely wet soil will have water moving both up and down. Dry soil will have water moving only up during freezing.

Just as weather forecasters speak of a cold front above ground, soil scientists describe a freezing front below ground. This is the plane where soil is starting to freeze, and it is there that water is attracted. In Minnesota, this water accumulation occurs from late November to late February. This is usually a time when no water enters the soil from the surface. Later, water from melting snow can flow down through the frozen soil to deeper, unfrozen soil.

With each freeze/thaw cycle, soil aggregates become finer and less strongly bonded. This sets up soil for damage from tillage and makes it more likely to move when struck by raindrops or pushed by water flowing across fields. However, freezing and thawing can improve a badly compacted soil by opening it up.

"The basic information on freeze-thaw cycles has been known for a long time. What we're adding is numbers gathered from careful measurements over many years," Benoit says.

Tracing water movement is important because spring crops can only use water stored within reach of their roots. In a cool climate like Minnesota's, the upward movement of water caused by frost is a big plus. Water that accumulates in the upper 2 feet of soil provides moisture needed for quicker seed germination and for early plant growth.

Frost Model Updated

"The frost [computer] model we have now is constantly being updated," says Benoit. "The plan is to incorporate it into the new USDA wind and water erosion models being developed. They will be tested this year and should be used widely by USDA's Soil Conservation Service in the 1990's."

"The frost model will also be used in the Agricultural Non-Point-Source Pollution Model (AGNPS)," says Benoit. This model, moving into use worldwide, estimates the amount of fertilizer, nitrogen, and phosphorus dissolved in surface runoff or attached to floating soil particles.—**By Don Comis, ARS.**

George R. Benoit is at the USDA-ARS North Central Soil Conservation Research Laboratory, Morris, MN 56267 (612) 589-3411. ♦

Russian Gauges at Reynolds Creek

Agricultural Research Service engineers have joined a worldwide effort to improve current methods of measuring snowfall.

The study is part of the World Meteorological Organization's (WMO) 5-year, 22-country study to determine which snow-measuring devices give the truest readings.

"If, based on snowmelt information, we could forecast the size of tomorrow's water supplies, we'd have a strong economic tool," says agricultural engineer Clayton L. Hanson at ARS' Northwest Watershed Research Center in Boise, Idaho. "On an international level, snowfall data could help us project irrigation and power supply needs, predict wheat yields and reservoir levels, and forecast floods, drought, and famine.

"Any international exchange of climatic data benefits everyone," says Hanson, "but the data has to be recorded with uniform measuring techniques. With our new gauges, engineers from different countries could obtain accurate measurements by using the same instruments or by mathematically correcting their existing data."

RANDALL MORGAN

Hydrologic technician Delbert Coon checks an unshielded U.S. snow gage. Gauges record collected precipitation (rain or snow) and are used in pairs, unshielded and shielded, for greater accuracy. The shielded one at left is barely visible in the fog. (88BW2224-18)

RANDALL MORGAN

Agricultural engineer Clayton Hanson prepares a snow measuring cylinder in one of the two Russian snow shields at the Reynolds Creek Experimental Watershed, southwest of Boise, Idaho. (88BW2225-5)

The snow gauges—some are shielded against the wind by specially designed picket fences—will be tested at ARS' Reynolds Creek Experimental Watershed about 50 miles southwest of Boise. Reynolds Creek Watershed is about 4,000 feet in elevation, gets about 2 feet of snow a year, and is next to irrigated farmland.

It's also one of only three U.S. locations being used in the study. The other two are the U.S. Geological Survey site in Steamboat Springs, Colorado, and the U.S. Army Corps of Engineers site in Danville, Vermont.

Al Rango, chief of the ARS Hydrology Laboratory in Beltsville, Maryland, says, "The Reynolds Creek Watershed site was included in the study because of its mild climate and gently sloping sagebrush and grass rangeland, typical of the mountainous Pacific Northwest. The site has also provided years of precipitation measurements and other climatic data to support this study."

The Boise engineers will evaluate eight gauges or gauge/windshield combinations, including two from the Soviet Union. "We'll also compare a snow-gauge system from Canada and five from the United States, including two dual gauges used at Reynolds Creek since 1967," says Hanson.

Each U.S. gauge consists of a metal cylinder—8 inches in diameter by 3.5 feet tall—fastened to a wooden post so that the gauge opening is 10 feet above the ground.

One of the gauges is unshielded. The other is shielded from the wind by a metal picket fence. The bottom of the fence inclines slightly toward the gauge, which sits in the center.

The Russian gauges are about 6 inches across and a foot high and are mounted with their openings 7 and 10 feet above the ground. One is surrounded by a pair of wooden picket fences, one inside the other. The outer fence is 40 feet across.

To measure the precipitation trapped by some gauges, the snow is melted and the water is poured into a graduated glass jar. Other gauges, like the U.S. one, have internal scales that constantly weigh and record precipitation.—By **Howard Sherman,** ARS.

Clayton L. Hanson is at the USDA-ARS Northwest Watershed Research Center, 270 South Orchard, Boise, ID 83705 (208) 334-1363.♦

Harmful Seeds: Taking a Closer Look

Seeds of weeds such as morning glory, black nightshade, jimsonweed, sicklepod, and velvetleaf may be harmful—if you eat enough of them—and may inadvertently be harvested with grain growing in the same field.

The U.S. Food and Drug Administration (FDA) makes routine checks to be sure the grain that ends up in our food is safe to eat. But occasional complaints about these seeds in exported grain, combined with the widespread occurrence of some of these weeds on U.S. farms, have led to new Agricultural Research Service studies on toxic weed seeds.

Agency scientists with the Food Safety Research unit, Albany, California, completed preliminary studies last year on toxicity of five weed seeds and more detailed experiments with three of the weed species.

For some experiments, the researchers used infrared beams and computers for electronic surveillance of laboratory rats, says research chemist Mendel Friedman. The equipment provided detailed, around-the-clock records of how the seed affected the animals' activity, he says.

The scientists expect their findings to be useful not only to FDA but also to USDA's FGIS—the agency responsible for setting inspection and grading standards for all our major grain crops. The Inspection Service sponsored part of the Albany laboratory's research.

Tests of laboratory rats that ate jimsonweed seed with their feed for 90 days showed that there was apparently no detectable damage to the liver or other organs or tissues of the animals, including those fed the highest doses of the seed.—By **Marcia Wood,** ARS.

Mendel Friedman is with USDA-ARS, Food Safety Research Unit, Western Regional Research Center, 800 Buchanan St., Albany, CA 94710

TIM McCABE

Research chemist Michael Gumbmann (retired) at left, and biologist Glenda M. Dugan evaluate the effects of jimsonweed seed on rats, using automated behavior-monitoring equipment. Tests are to determine safe levels of weed seeds that can be allowed in grain. (0787X725-24)

Why Some Cows Fight Mastitis Better

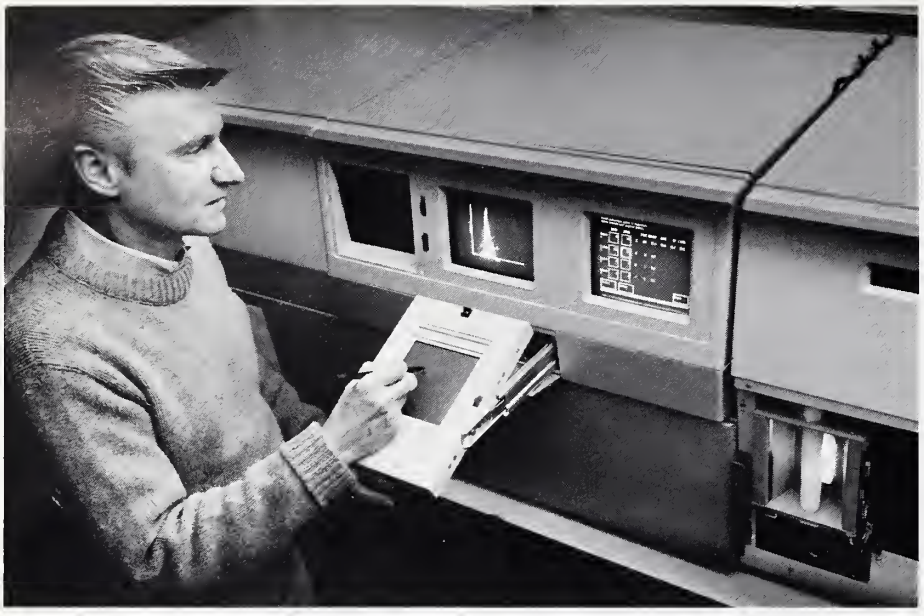
Dairy cows have at least four types of neutrophils—white blood cells that track down and engulf invading bacteria—Max J. Paape and Albert J. Guidry of USDA's Agricultural Research Service have discovered.

It's the first time any animal species has been shown to have more than one type of neutrophil cell.

"Our discovery of four different subpopulations of neutrophils," says Paape, "may lead to an explanation of why cows differ in their ability to fight mastitis, a bacterial infection of the udder that costs U.S. dairy farmers $2 billion annually in medication and lost milk production."

In cows, mastitis-fighting neutrophils have to exit blood vessels and enter the udder to find their targets, which are any of several different kinds of bacteria that enter through the teat. But neutrophils alone usually can't do the job; if mastitis is not treated with medicines, it can kill a cow.

"We are testing to see which types are more active against bacteria," Paape says. "It may be possible to breed cattle with neutrophils that will resist the disease."



JOHN KUCHARSKI

ARS dairy scientist Max Paape watches the screen of a flow cytometer which is graphing populations of neutrophils (white blood cells) in a sample. Paape's research shows that there are at least four different subpopulations of the bacteria-eating cells in dairy cattle. (88BW2065-19)

To separate the four subpopulations of neutrophils, the researchers made highly specific proteins called monoclonal antibodies. They programmed the antibodies to attach to broad-spectrum neutrophils.

Crucial to the research was a flow cytometer—a sophisticated cell analyzer originally designed for clinical blood and cancer tests. The heart of this machine is a laser that illuminates and analyzes cells.

"The four monoclonal antibodies were incubated with four separate batches of neutrophils from the same cow to determine if they recognized antigenic sites on the cell surface. The batches were placed in the machine one at a time and individually tested. When the laser beam hit a neutrophil, the monoclonal antibody attached to it glowed. The machine counted the glowing neutrophils in each batch, confirming that we had four distinctly different subpopulations of neutrophils," says Paape.

"The technology we used for cows is also being used by medical researchers to see if humans, too, have a variety of neutrophil subpopulations. If so, researchers may be able to find ways to boost the immune system in humans," says Guidry.—By **Vince Mazzola,** ARS.

Max J. Paape and Albert J. Guidry are in the Milk Secretion and Mastitis Laboratory, Bldg. 173, Beltsville Agricultural Research Center-East, Beltsville, MD 20705 (301) 344-2302 and 344-2285. ♦

Self-Destructing Alfalfa?

After 4 or 5 years in the same field, alfalfa often begins to decline. That's because alfalfa is autotoxic—that is, it produces something that hurts itself.

"It's odd, but it may actually be some form of defense mechanism," says Agricultural Research Service plant physiologist David L. Dornbos, Jr. "Some chemicals in plants are produced in order to defend the plant against insects, fungi, and other plants. But in this case, we're not yet sure why the plant is autotoxic."

So far, Dornbos and other researchers at the Bioactive Constituents Research Lab in Peoria, Illinois, have isolated the compound medicarpin from alfalfa roots and shoots and identified it as one of the culprit chemicals involved in the toxicity.

Medicarpin reduced the height of alfalfa seedlings growing in vials by 40 percent after 72 hours. It also delayed germination for 4 hours and seedling growth for 48.

During that time, the alfalfa seedlings detoxified most of the medicarpin. After 48 hours, when the amount of medicarpin had been reduced 85 percent, seedling growth resumed at the normal rate.

Researchers also found that soil with medicarpin can have a significant impact on seedlings exposed to the compound. In soil where medicarpin was removed with an organic solvent, seedling emergence was 16 percent greater than in soil containing the compound.

"One interesting fact about medicarpin is that it may be useful as a natural herbicide," Dornbos says. "Because it occurs naturally, it is more likely this compound and others like it will degrade in the soil and reduce the groundwater contamination problem."

So far, medicarpin has been found to reduce the height of velvetleaf seedlings, which are pests of soybeans, corn, and cotton. But Dornbos says more work needs to be done before medicarpin can be turned against weeds.

In cooperation with Iowa State University, researchers will first examine 10 different alfalfa varieties to determine if the plants produce different levels of the compound. The short-term goal is to find a large and reliable source of medicarpin for laboratory studies.—By **Matt Bosisio,** ARS.

David L. Dornbos, Jr., is at the USDA-ARS Bioactive Constituents Research Laboratory, Northern Regional Research Center, 1815 North University St., Peoria, IL 61604 (309) 685-4011. ♦

Breeding for Early Bloom

Soybean researchers may have found a good early indicator to help select plants for higher yields.

The indicator—a tendency to bloom earlier than usual—may make it easier to breed soybean varieties that make more efficient use of sunlight, soil fertility, and moisture.

After observing that the newer commercial varieties also tend to develop beans in the pods over a longer time, Agricultural Research Service geneticist Randall L. Nelson, Urbana, Illinois, began exploring the effect of purposefully selecting lines for early bloom and pod fill from crosses between existing varieties.

He crossed a standard variety, Williams, with a somewhat poorer yielding variety, Kanrich. From that cross, he selected lines according to both flowering and maturity dates to shorten or lengthen pod-filling periods by several days.

"In a 2-year test, our best early-blooming line outyielded the best late-blooming line by 10 bushels per acre and the parent Williams by 6 bushels per acre, or 15 percent," says Nelson.

Nelson cautions not to expect the finding to start a rapid buildup of soybean surpluses. Many other traits influence seed yield, and the early-blooming line did not yield as well as Harper, a current high-yielding variety.

"Breeders have inadvertently selected for early blooming and long pod-filling periods in their quest for higher yields," Nelson says. Now, by deliberately using these selection criteria, we may help continue a trend of increasing yields to meet long-term market demand.—By Ben **Hardin**, ARS.

Randall L. Nelson is in USDA-ARS Plant Physiology and Genetics Research, Department of Agronomy, University of Illinois, 1102 South Goodwin Ave., Urbana, IL 61801 (217) 244-4346. ♦

Patents

New Lure Attracts Medfly Males

A new and longer lasting lure for trapping the Mediterranean fruit fly (medfly) may become an important defensive weapon for California and other states that are susceptible to invasions of this destructive insect.

The new formula, Ceralure, lasts at least twice as long as the most widely used lure—Trimedlure—according to ARS scientists Terrence P. McGovern, a research chemist at Beltsville, Maryland, and Roy T. Cunningham, a research entomologist at Hilo, Hawaii. They took the name for their new formula from the scientific name for medfly, *Ceratitis capitata.*

Ceralure might be used inside thousands of traps that agricultural agents in states such as California, Texas, Arizona, and Florida hang on trees in prime, multibillion dollar crop-growing areas. They monitor traps year around to detect immigrant medflies.

Invasions that aren't zapped in time cost millions in eradication expenses and lost sales of fresh fruits and vegetables.

That's why, when 31 medflies showed up in traps during a single week in west Los Angeles last fall, agricultural agencies hurriedly fought back with sterile flies and insecticides, stopping what might otherwise have become a major outbreak.

Mediterranean fruit fly. (PN-7279)

Medflies could easily adapt to living in states that offer a mild, sunny climate, and an abundant supply of some of the more than 250 different crops the flies can infest.

McGovern and Cunningham replaced Trimedlure's chlorine atoms with iodine atoms and changed its alcohol component from a four-carbon to a more stable two-carbon component. They also rearranged the ratio of what are known as isomers, so that Ceralure has a greater proportion of the isomer that proved to be the best attractant.

Ceralure's ability to stay "fresh" longer than Trimedlure means traps should need to be replenished with the new chemical less often. Impressive savings in labor costs could result for states like California, which maintains 30,000 medfly traps.

The new attractant is made in the laboratory using readily available chemicals that are heated under pressure, then purified. Ceralure's chemical name is ethyl 4(and 5)-iodo-trans-2-methylcyclohexanecarboxylate.

Experiments planned for Hawaii should show how well the new lure performs in modern plastic dispensers, which may replace cotton wicks saturated with lure.—By **Marcia Wood,** ARS.

For technical information about this patent, contact Terrence P. McGovern, USDA-ARS, Insect Chemical Ecology Laboratory, Room 8, Bldg. 010, BARC-West, Beltsville, MD 20705 (301) 344-2138. Patent No. 4,764,366, "Persistent Attractants for the Mediterranean Fruit Fly, the Method of Preparation and Method of Use."

For information on licensing patents listed on this page or to receive a catalog of USDA patents, contact Ann Whitehead, coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705. ♦

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